ANOA / AI-NATIVE ORGANIZATIONAL ARCHITECTURE

ESSAY XV

The Axiomatic Theory of Distributed Monetary Circulation in AI-Native Economies

Money Creation · Endogenous Credit · Agentic Transactions
Federated Settlement · Protocol Federalism · Human Sovereignty

INSTITUTIONAL INTEGRATED RESEARCH MANUSCRIPT

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The Axiomatic Theory of Distributed Monetary Circulation in AI-Native Economies

Extended and consolidated research manuscript | Version 0.2 | 8 November 2026

Money Creation · Endogenous Credit · Multi-Currency Equilibrium · FX · Collateral · Federated Settlement · Agentic Monetary Transmission · Human Sovereignty

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Abstract

This expanded manuscript develops a technology-neutral, stock-flow-consistent account of monetary circulation in agent-mediated and federated economies. It preserves the accounting, issuer, authorization and settlement distinctions established in the initial Essay XV draft and extends them to endogenous bank credit, multi-currency payment networks, foreign-exchange liquidity, collateral constraints, bank optimization, payment queues, operational controllability and network-dependent monetary-policy transmission. A balance-sheet-consistent settlement construction and conditional propositions establish what can be deduced under specified assumptions; numerical examples are illustrative rather than calibrated evidence. The analysis distinguishes contractual HomeSelf infrastructure service rights from monetary liabilities and does not require blockchain or claim to establish a new currency. The full theory of equilibrium is explicitly conditional on behavioral, legal and institutional closures. Human authorization, reversibility, auditability and monetary pluralism remain governing principles.

Keywords: stock-flow consistent; agentic payments; endogenous credit; foreign exchange; collateral; settlement finality; federated monetary circuit; inferential scarcity; computational liquidity; monetary transmission. JEL: E40, E42, E51, E52, G21, G28, D85.

Part I — Preserved foundations from the original research draft

1. Scope, continuity and scientific boundary

Essay XIV established that monetary solvency does not guarantee consideration by an agent-mediated market and that an agentic allocation decision is not identical to lawful execution or settlement. Essay XV retains these separations and adds the monetary balance-sheet layer. It does not presume that AI agents may lawfully issue money, that one currency will replace sovereign money, or that the network has achieved operational deployment. The research method is constructive: accounting identities, conditional propositions, counterexamples, architecture comparisons and falsifiable mechanisms.

2. Ontology: five distinct objects

Object Definition Not equivalent to

Monetary claim A liability of an identified issuer accepted under A generic database entry. specified monetary rules.

Payment instruction A mandate-bound request to transfer or discharge Completed settlement. an obligation.

Settlement event An event satisfying the applicable legal and Merely submitting an API call. operational finality rules.

Asset allocation Selection of assets within inferential, liquidity, risk Payment or legal title transfer. and authority constraints.

HSC service right Non-transferable prepaid right to specified Bank deposit, CBDC or infrastructure services under contract. general-purpose money.

3. Actors, domains and accounting perimeters

Let d denote a jurisdictional or operational domain, k a class of monetary liability, i an economic actor, and j an issuer. A bank deposit denominated in EUR and an EUR central-bank reserve are different liabilities even though both are recorded in euros. Let L(j,k,t) be the outstanding liabilities of issuer j in class k; A(j,t) the issuer assets; and E(j,t) equity. The balance-sheet identity is A(j,t) = L(j,t) + E(j,t), with explicit valuation conventions and off-balance-sheet commitments treated separately. Consolidation eliminates intra-group claims, not obligations owed to outside parties.

4. Axioms of a federated agentic monetary circuit

A1 — Double-entry integrity. Every monetary creation, transfer, extinguishment or reclassification is represented by offsetting postings in the relevant accounting perimeters.

A2 — Issuer specificity. A unit of account does not erase distinctions between issuers, redemption terms and legal priority.

A3 — Mandate restriction. An autonomous agent may propose or initiate monetary actions only within verifiable delegated authority.

A4 — Settlement separation. Instruction, acceptance, clearing and final settlement are distinct states unless a lawful mechanism combines them.

A5 — Domain plurality. Interoperability need not entail a common ledger, common issuer or common currency.

A6 — Liquidity feasibility. Execution requires sufficient eligible funding, credit, collateral or settlement capacity under the applicable rules.

A7 — Inferential selection. The transactions agents request depend on bounded consideration sets and allocation objectives.

A8 — Contingent stability. Interconnected agents, payment queues and liquidity constraints may create feedback and correlated failure.

A9 — Legal priority. Technical confirmation does not override applicable insolvency, settlement-finality or consumer-protection law.

A10 — Human sovereignty. Autonomy remains accountable, bounded, contestable and revocable through legitimate institutions.

5. Transfers versus monetary creation

For a fixed issuer and liability class in a closed perimeter, let b(i,t) be participant balances and f(i,j,t) a valid transfer from i to j. Ignoring fees and external flows, the ledger updates as follows:

b(i,t+1) = b(i,t) + SUM_j f(j,i,t) - SUM_j f(i,j,t)

SUM_i b(i,t+1) = SUM_i b(i,t)

Proposition 1 — Conservation under internal transfers. If every transfer is recorded as an equal debit and credit within the same liability class and perimeter, the aggregate outstanding balance is unchanged. Proof. Each f(i,j,t) occurs once as a debit and once as a credit; summing across all i cancels every internal flow. This does not assert conservation across creation, repayment, reclassification, default, fees leaving the perimeter or issuer consolidation.

Bank credit creation is different. When a deposit-taking bank grants a qualifying loan and credits the borrower deposit, it records an asset (loan) and a liability (deposit); repayment funded by a deposit reduces both. Such creation remains constrained by capital, funding, liquidity, risk, regulation and borrower demand. An agent transferring an existing deposit does not, by that fact alone, create new aggregate bank deposits.

Delta Loans_bank = +q ; Delta Deposits_bank = +q (illustrative origination)

Delta Loans_bank = -r ; Delta Deposits_bank = -r (illustrative principal repayment)

Proposition 2 — Transfer non-equivalence. An authorized agent transferring an existing deposit between two holders at one bank changes ownership of the claim but does not by itself change total deposit liabilities. Proof. One deposit balance falls by q and another rises by q. Fees, bank-to-bank transfers and credit events require additional postings.

6. Interbank settlement and central-bank reserves

Consider a payer at Bank A and a recipient at Bank B. The payer deposit at A decreases and the recipient deposit at B increases, while the banks settle an interbank obligation using reserves or another legally recognized arrangement. At the consolidated commercial-bank level, total deposits may remain unchanged; at the individual bank level, liabilities and reserve assets shift. Liquidity and collateral constraints may prevent immediate settlement even where the payer has sufficient deposits.

Proposition 3 — Customer solvency is not sufficient for immediate interbank finality. Construct Bank A with an adequately funded customer but temporarily insufficient settlement liquidity and no available intraday credit. A valid payment instruction may enter a queue rather than settle immediately. This is a feasibility counterexample, not a prediction of routine payment failure.

7. Agentic allocation generates conditional payment demand

Let R(b,t) be agent b’s inferential consideration set and F(b,t) its legally and financially feasible allocations. Agent b selects x* from F to optimize a stated mandate. A payment request q(b,i,j,t) is generated only after an authorization rule M(b,t) accepts the proposed action. A payment service provider may then reject, queue, accept or settle the request independently of the agent’s optimization outcome.

x*(b,t) in argmax_{x in F(b,t;R)} [ExpectedUtility(x) - RiskCost(x) - Fees(x)]

RequestedFlow(i,j,t) = G(x*, mandate, prices, obligations, compliance)

Proposition 4 — Access exclusion can attenuate direct monetary transmission. If an asset is never included in any agent consideration set and no alternative demand channel exists, increasing the agents’ spending budgets does not create direct payments for that asset. Proof. The asset’s allocation variable remains constrained to zero. The proposition excludes indirect demand, changing consideration sets and general-equilibrium effects.

8. Liquidity, queueing and synchronized agent behavior

A circuit may be solvent in an accounting sense while suffering intraday gridlock. Let Q(t) be unsettled payment requests, A(t) arrivals and S(t) completed settlements. A basic queue identity is Q(t+1)=max(0,Q(t)+A(t)-S(t)). Settlement capacity depends on reserves, collateral, limits, network outages, operating hours and liquidity-saving mechanisms. Correlated agents can concentrate payment arrivals even if total daily demand is unchanged.

Proposition 5 — Synchronized demand can create a queue without additional aggregate expenditure. Suppose a processor handles at most 10 instructions per time interval. Twenty requests arriving simultaneously leave at least 10 unsettled at the end of the first interval; the same twenty arriving as two batches of ten do not. This is a queue-capacity result; actual financial stability depends on value-weighted flows, priority and liquidity rules.

9. A stock-flow-consistent monetary state vector

For each domain d define a state vector z(d,t) containing deposits by issuer, reserve holdings, outstanding loans, due obligations, payment queues, collateral, FX positions and agent authorization states. Monetary dynamics are expressed as an accounting-constrained transition:

z(t+1) = T(z(t), approved agent requests, credit events, policy, shocks)

The transition must preserve each issuer’s balance-sheet identities, settlement rules and conservation of internal transfers. Aggregate money measures must state which liabilities are counted, which sectors are consolidated and which instruments are excluded. No scalar “AI money supply” is assumed to exist independently of those definitions.

10. Federated cross-domain settlement and foreign exchange

An agent-mediated transaction between EUR and SGD domains may involve (i) a binding commercial obligation, (ii) an FX quote and hedge, (iii) payment instructions to distinct providers, (iv) liquidity provisioning, (v) settlement in two systems and (vi) final reconciliation. The exchange rate is not determined by protocol interoperability alone. The architecture should explicitly model principal risk, time-zone mismatch, sanctions controls where applicable, reversal rights, settlement finality and dispute resolution.

Proposition 6 — Interoperability does not imply a single monetary issuer. Construct two independent lawful ledgers, one recording EUR liabilities and one SGD liabilities, linked by signed instructions and a regulated FX intermediary. The domains can coordinate a payment without sharing an issuer, ledger or unit of account. This is an existence construction; operational and legal feasibility depends on actual institutional arrangements.

11. Technology-neutral architecture comparison

Architecture Possible strength Key dependency / risk

Bank APIs and conventional Established legal money and regulated Access rules, provider concentration, rails settlement institutions. schedules, operational interoperability.

Federated signed ledgers Domain autonomy, audit logs, explicit Trust anchors, dispute resolution, (non-DLT) reconciliation and adaptable governance. consistency, asynchronous finality.

Permissioned DLT / unified Shared programmable state, conditional Consensus governance, privacy, legal ledger transfer and possible atomic finality, common technical failure. delivery-versus-payment.

Public blockchain Open verification and permissionless Volatility of native assets, throughput, fees, validation in some designs. privacy, uncertain legal treatment.

A distributed ledger is neither necessary nor sufficient for monetary validity. Even BIS unified-ledger analysis recognizes architectures that may or may not employ DLT. Technology choice should follow legal finality,

throughput, privacy, governance, resilience and the trust model rather than ideology.

12. Conditional atomicity, delivery-versus-payment and failure recovery

An agent may coordinate asset delivery and payment through a conditional protocol, but atomic technical execution is not necessarily identical to legally final transfer of ownership. A rigorous design must specify when a claim becomes irrevocable, who can unwind it, how insolvency is treated, and how the system recovers from partial failures. Two-phase commit, escrow, time locks and DLT-based conditional settlement have different trust and failure models.

Proposition 7 — Technical atomicity does not establish legal finality. A software protocol can atomically change two internal database entries while the applicable law conditions property transfer on a separate registry action. Hence software atomicity alone is insufficient to prove final title transfer.

13. Monetary policy and network-dependent transmission

Monetary policy may affect funding rates, balance sheets, bank credit, asset prices, expectations and exchange rates. In AI-mediated markets, the distribution of these effects may additionally depend on which assets and suppliers agents consider, and on payment-system throughput. A candidate empirical specification is:

Delta y(h,t) = B_m(N,R,ownership,liquidity) * policy_shock(t) + controls + error

Here B_m is not an estimated coefficient. Identification would require a policy-shock design, observed network-access measures, agent-mediated transaction shares, pre-trends, time lags and controls for endogenous platform selection. The theory does not imply that conventional channels cease to operate.

14. Stability, contagion and operational controllability

Let z(t+1)=A z(t)+B u(t)+epsilon(t) locally approximate coupled payment queues, infrastructure availability and agent request rates. Stability of isolated components does not guarantee stability of A after coupling, as shown in ANOA Essay IX. The system must incorporate throttling, circuit breakers, liquidity caps, revocable mandates, human override, audit trails and independent recovery paths. Federated labels alone do not ensure independent failure domains (ANOA Essay XIII).

Proposition 8 — A coupling instability counterexample. For A=[[0.6,0.5],[0.5,0.6]], isolated diagonal dynamics have coefficients 0.6 but the full matrix has eigenvalue 1.1, exceeding the discrete-time stability threshold. Therefore local stability is not sufficient for joint stability. This does not establish instability in any deployed system.

15. Production, ownership and household purchasing power

Agentic coordination can improve resource matching while leaving distribution unresolved. ANOA Essay XII separates computational production from ownership and income distribution; Essay X separates monetary clearing from real welfare. A household may face greater output and abundant settlement liquidity yet have insufficient income or inferential access to participate. Monetary-circuit design should therefore evaluate distribution, access and contestability rather than transaction throughput alone.

16. HSC and the non-monetary infrastructure funding layer

HomeSelf Credits are considered prospective non-transferable prepaid contractual rights to specified infrastructure services. They may support representation, inferential access and mandate-bound allocation capabilities; they are not assumed to circulate as general-purpose payment media, constitute bank deposits, or promise financial returns. Their contractual denomination and future utility are separate from issuer backing and from the sovereign monetary settlement of asset trades. If the commercial terms change materially, classification requires renewed legal and accounting assessment.

17. Constitutional principles for monetary infrastructure

Human primacy. Economic agents remain delegated instruments, never autonomous sovereign authorities.

Monetary truth. Every claim must disclose issuer, unit of account, redemption and settlement character.

Separation of powers. Asset selection, authorization, custody, monetary issuance and settlement must not be silently conflated.

Contestable access. Inferential exclusion should be transparent, proportionate and subject to effective remedies where appropriate.

Operational reversibility. Mandates must be bounded, auditable and revocable; emergency controls must be independently testable.

Pluralism and interoperability. Interoperability must respect lawful monetary institutions and jurisdictional authority.

Resilience and responsibility. No architectural design is legitimate merely because it is computationally efficient.

18. Falsifiable hypotheses and limits

H1: Holding creditworthiness and price constant, lower inferential accessibility is associated with reduced direct agent-mediated demand. H2: Synchronized agent payment requests increase intraday queue volatility conditional on processing capacity. H3: Shared identity or settlement gateways create correlated outage exposure even in nominally federated networks. H4: Higher interoperability reduces some reconciliation costs without necessarily changing monetary issuer structure. H5: The effect of monetary policy on transaction volume varies with the measured share of agent-mediated consideration. These are research hypotheses, not established facts.

The present model does not solve multi-currency equilibrium, endogenous FX rates, bank optimization, collateral chains, money demand, regulatory capital calibration, optimal monetary policy or universal settlement finality. It supplies accounting identities, existence counterexamples and architecture-neutral mechanisms. Its empirical implications remain untested. No new currency is proposed or issued by this manuscript.

19. Institutional conclusion

AI-native monetary circulation is best defined initially as a new mode of coordinating economic instructions across existing and potentially new lawful monetary claims, not as a presumption that money must become a blockchain token. Agentic autonomy can alter transaction initiation, timing and network concentration while leaving issuer liabilities, balance-sheet integrity and legal finality indispensable. The architecture must make its powers explicit: agents may propose and allocate within mandate; institutions authorize and settle; humans retain responsibility and recourse.

Stoic constitutional maxim: We govern what we can authorize, verify and correct. A ledger is not legitimacy. Speed is not solvency. Intelligence is not sovereignty. Money serves human coordination; it does not rule humanity.

Part II — Extended monetary-circuit analysis

20. Formal monetary balance-sheet network and clearing operators

Let J be the set of issuers, I the set of holders, K the set of liability classes and D the set of monetary domains. Define b(i,j,k,d,t) as the claim of holder i on issuer j, measured in the specified unit of account. Total liabilities of issuer j in class (k,d) are L(j,k,d,t)=SUM_i b(i,j,k,d,t). Issuer balance sheets require A(j,t)=SUM_(k,d) L(j,k,d,t)+E(j,t), with valuation and contingent obligations separately disclosed.

A same-issuer transfer q from payer p to receiver r is an incidence-vector posting: Delta b(p,j,k,d)=-q and Delta b(r,j,k,d)=+q. An inter-issuer transfer is not this operation alone: it changes two distinct liability stocks and creates a corresponding settlement-asset transfer or enforceable interbank obligation. Define the signed incidence matrix N for a directed payment network; internal balance updates satisfy Delta b=Nf, hence 1-transpose Nf=0, only when all included flows use one issuer/class/perimeter.

Proposition 9 — Perimeter-dependent conservation. Aggregate balances are conserved under internal transfers for a fixed issuer and class, but need not be conserved across issuer boundaries or when credit, defaults, fees, redemption and sectoral consolidation enter the perimeter. Proof: the incidence matrix has column sums zero for included internal edges. For external edges, the omitted counterpart invalidates the cancellation. This is an accounting identity, not a behavioral law.

An auditable circuit must specify whether its state variable represents gross deposits, consolidated bank liabilities, central-bank reserves, or an aggregate broad-money definition. A protocol that merges these categories cannot establish a valid monetary conservation theorem.

21. Endogenous bank credit, repayment and deposit migration

Consider a commercial bank originating a loan q to a nonbank borrower. Under a simplified same-bank disbursement, assets (loans) rise by q and liabilities (deposits) rise by q. If the borrower pays a supplier at another bank, the originating bank may lose reserves and deposits, while the receiving bank gains both. Deposit creation and reserve redistribution are distinct accounting events. Loan repayment by debit of a bank deposit contracts the bank loan and deposit by the repaid principal, subject to fees, accrued interest and the exact counterparty.

Define new lending C_t, principal repayment R_t, write-offs W_t, and reclassifications X_t. A simplified loan-stock equation is L_(t+1)=L_t+C_t-R_t-W_t+X_t. A corresponding deposit equation additionally contains fiscal flows, asset purchases, cross-sector transfers, interest, bank capital transactions and consolidation effects; therefore Delta deposits is not generally equal to Delta loans over arbitrary horizons.

Bank lending decisions are endogenous: C_t=argmax_(C in feasible set) expected net interest margin minus credit losses, capital costs, liquidity costs and regulatory penalties, subject to borrower demand and creditworthiness. An agent can request a loan but cannot, by that request alone, confer bank licensing, create lawful central-bank liabilities or remove underwriting constraints.

Proposition 10 — Agent initiation is not monetary issuance. If the authority to issue liabilities remains exclusively with identified licensed or otherwise lawful issuers, a software agent generating payment or loan instructions cannot independently increase the relevant monetary stock absent an issuer-approved credit or issuance event. Proof: the state-transition rule requires an issuer posting to change outstanding liabilities.

22. Multi-currency circuit and conditional equilibrium closure

Let d index currency domains and e_(d,h,t) denote units of currency d per unit of currency h. Let M_d be a carefully specified monetary aggregate, P_d a price index, Y_d real output, i_d the relevant interest rate, and v_d transaction velocity defined over a stated transaction class. An accounting identity of the form M_d v_d=P_d T_d may be defined for matching nominal transaction value T_d; it is not a causal determination of prices or a universal constant-velocity law.

For a closed equilibrium model, add household budget constraints, bank balance-sheet feasibility, asset market clearing, FX dealer balance sheets, issuer rules, fiscal accounts, agent selection sets and goods market clearing. Let excess demands Z_d(e,p,i;theta) depend on FX quotes, goods prices, interest rates and institutional parameters. Conditional equilibrium requires Z_d=0 in the modeled markets together with valid balance-sheet and settlement constraints.

Proposition 11 — Accounting consistency is insufficient for price or FX uniqueness. A system of balanced monetary ledgers can admit multiple admissible FX prices when no preference, arbitrage, intervention or market-clearing closure selects a unique rate. Counterexample: two independent currencies with no cross-currency trades satisfy all balance-sheet identities for any positive quoted exchange rate. Thus a unique equilibrium requires additional assumptions.

For multi-domain solvability, a candidate sufficient-condition route is continuity of excess-demand mappings, compact feasible allocations, convex preferences and a properly normalized price simplex; these are modeling choices, not properties established for actual AI-native markets. Transaction-cost, capital-control and legal barriers can prevent textbook arbitrage equalization.

23. FX settlement, liquidity and principal risk

For a cross-border exchange, agent A sells q_E EUR against q_S SGD at quote e=q_S/q_E. Commercial agreement, FX execution, each currency payment instruction and each legal settlement event must be modeled separately. Without coordinated settlement, one leg can settle while the other fails, exposing a participant to principal risk.

A payment-versus-payment mechanism can condition the release of each leg on satisfaction of both settlement conditions. However, legal enforceability, access to the relevant payment systems, cut-off times, currency controls and dispute processes remain exogenous requirements. A two-phase protocol with a trusted coordinator can improve coordination without proving legal finality or universal failure recovery.

Proposition 12 — Asynchronous two-leg exposure. If the EUR leg settles irrevocably at t1 and the SGD leg settles only at t2>t1, then for t in (t1,t2) the payer of the first leg has an unmatched exposure, unless an independent guarantee or legally effective offset covers it. Proof follows from the unequal timing of final settlement events.

Institutional implication: interoperability should expose currency, issuer, settlement venue, available liquidity, FX quote expiry, counterparty and cancellation rights in machine-readable but legally governed form.

24. Collateral chains, haircuts and intraday liquidity

Let c_i be collateral market value posted by participant i, h_i its eligible haircut, and k_i available secured credit. A stylized bound is k_i <= (1-h_i)c_i, further restricted by eligibility, concentration limits, margining and counterparty discretion. Reuse of collateral can create chains of claims whose gross exposures exceed underlying unencumbered collateral; such reuse must be tracked separately from ultimate ownership and legal priority.

An intraday payment feasibility condition is outgoing value <= available reserves + legally available credit + realized incoming settled value, with timing, priorities and netting rules explicitly specified. Gross nominal

solvency does not imply intraday liquidity at every payment instant.

Proposition 13 — Haircut shock can induce queueing without a change in underlying transaction demand. Let a participant require 90 units of intraday liquidity, hold collateral worth 100, and initially face h=0.05, yielding up to 95 units. If h rises to 0.20, available secured credit falls to 80; absent other funding, at least 10 units of requested settlement must be deferred or canceled. This is a stylized feasibility result.

Collateral eligibility is issuer- and jurisdiction-specific. No generalized ability to transform infrastructure service credits into central-bank collateral is assumed.

25. Bank behavior, liquidity pricing and credit allocation

For bank j define a choice vector (new loans, reserve buffers, liquid securities, funding, intraday credit use). A stylized objective is maximize expected profit net of funding cost, expected loss, operational cost, capital charges and liquidity shortfall penalties. Constraints include regulatory capital, liquidity coverage, reserve and settlement arrangements, concentration and legal exposure limits. This permits bank responses to agent-generated transaction flows to be modeled without assuming frictionless credit.

Inferential concentration can affect loan demand and repayment expectations through borrower visibility, but the direction of the effect is conditional. Better information may reduce some screening costs; exclusion or synchronized allocations may concentrate risks. Both channels must be retained in the model.

Proposition 14 — Greater allocative throughput does not imply greater credit supply. Construct a bank at a binding capital constraint: reducing payment processing time changes neither its capital headroom nor its feasible maximum loan book. Therefore an improvement in agentic settlement throughput need not increase credit issuance.

Empirical calibration would require bank-level balance sheets, credit decisions, intraday liquidity measures and actual exposure to agent-mediated demand; absent those data the model remains structural.

26. Agentic monetary demand, velocity and synchronization

An agent generates requests conditional on accessible alternatives, budget, delegated mandate, optimization rule and execution window. Let arrivals A_t have conditional intensity lambda_t=lambda(R_t, prices_t, mandates_t, shared signals_t). Queue dynamics satisfy Q_(t+1)=max(0,Q_t+A_t-S_t), with service S_t bounded by capacity and available settlement liquidity.

For a deterministic single-server toy system with capacity mu per interval, if average arrivals exceed mu over a sustained horizon, the queue cannot remain bounded without dropping, delaying or rerouting requests. Conversely, mean arrivals below capacity alone do not guarantee low tail latency when bursts and common shocks are large.

Proposition 15 — Synchronization amplifies peak liquidity needs under fixed total flows. For a fixed total of 100 value units, a schedule of ten payments of 10 spread across ten periods can require less peak outgoing funding than the same ten payments submitted simultaneously, when incoming funding and netting opportunities are time-dependent. The conclusion depends on the specified funding and netting rules; total expenditure remains 100.

The effect on measured money velocity is ambiguous: agents can accelerate some payments while concentrating idle buffers or increasing precautionary liquidity elsewhere. Velocity is an outcome to estimate, not an architectural promise.

27. Monetary policy transmission with inferential frictions

Let policy shock epsilon_m,t affect bank funding costs, asset values, credit supply, expectations and exchange rates. In an agentic economy, an additional mapping from available budgets to realized transaction flows is mediated by inferential accessibility R_t, mandates G_t and settlement capacity S_t. A local representation is Delta y_t=beta_m epsilon_m,t + beta_R Delta R_t + beta_S Delta S_t + beta_mR(epsilon_m,t * R_t)+u_t, with coefficients to be estimated, not assumed.

Proposition 16 — Direct transmission may be zero for excluded assets. If an agent may purchase only assets in R_t and a is excluded throughout the response horizon, then the direct agent purchase quantity of a remains zero regardless of a positive budget shock, provided no alternative channel or change in R_t is admitted. The result does not eliminate indirect demand, substitution or general-equilibrium effects.

Policy assessment must distinguish central-bank interest-rate and balance-sheet instruments from fiscal spending, public procurement and social transfers. A central bank does not acquire general authority to allocate assets simply because agentic markets exist.

Identification strategy: use externally measured monetary surprises, time-stamped agentic transaction shares, consideration-set coverage, bank credit supply, pre-trends and fixed effects; assess selection bias, reverse causality and heterogeneity by sector and household income.

28. Network stress testing and joint controllability

A stress-testing state should include reserves, deposits, collateral values, outstanding instructions, operational availability, issuer concentration, common identity providers, FX settlement legs and authorization status. Consider x_(t+1)=A x_t+B u_t+E w_t. Closed-loop stability requires an admissible control u_t, observability of critical state and authority to execute interventions.

Proposition 17 — Local resilience does not ensure federated resilience. Two domains may individually satisfy spectral radius below one yet the coupled system exceed one when shared settlement or identity dependencies produce sufficiently strong off-diagonal feedback. The Essay IX counterexample A=[[0.6,0.5],[0.5,0.6]] has eigenvalue 1.1.

Proposed stress scenarios: (i) simultaneous agent order bursts, (ii) reserve scarcity at a major settlement bank, (iii) sudden collateral haircut, (iv) FX leg outage, (v) shared authentication compromise, (vi) concentration of inferential consideration, and (vii) a cross-domain legal suspension. Measures include unpaid value, tail settlement delay, liquidity utilization, network loss propagation, reversibility and human intervention latency.

Human control is a functional requirement, not a rhetorical add-on: authority must be attributable, limits testable, actions logged, and emergency shutdown or throttling demonstrably effective.

29. Comparative architecture and technology-selection criteria

The comparison is among (a) regulated bank and payment-system APIs, (b) federated signed non-DLT records with reconciliation, (c) permissioned shared ledgers, and (d) public blockchain configurations. Evaluate each on legal finality, issuer specificity, privacy, throughput, governance, reversibility, operational independence, collateral integration, cost and recoverability.

Proposition 18 — Blockchain is not necessary for a federated monetary circuit. Construct two regulated payment domains using signed API messages, independent books, authenticated instructions and a lawful FX intermediary. If payments settle in each domain under its own legal rules and records reconcile, cross-domain coordination exists without any blockchain. This proves logical non-necessity, not universal efficiency.

Conversely, a blockchain ledger cannot by itself establish sovereign issuance authority, guarantee redeemability of a claim, remove credit risk or confer legal title. Its suitability depends on the trust model and the legal system.

The preferred research baseline is therefore technology-neutral. Any implementation decision should follow demonstrated operational requirements rather than assuming that tokenization and money are synonymous.

30. Integrated stylized accounting and settlement experiment

Initial state: Bank A holds 100 units of reserve assets and owes customer deposits of 500; Bank B holds 80 reserves and owes deposits of 400. Customer X at A owes 30 to customer Y at B. An authorized agent submits a valid 30 payment. After settlement, X deposits at A fall 30, Y deposits at B rise 30, reserves at A fall 30 and reserves at B rise 30. Across both banks, deposits remain 900 and reserves remain 180, assuming no fees or other events.

Now assume Bank A first grants X a new loan of 40 and credits a deposit of 40. Bank A loans and deposits rise by 40. When X transfers 30 to B, aggregate bank deposits remain 940 while 30 reserves move from A to B. This is a deliberately simplified two-bank example; it distinguishes loan-created deposits from payment-settlement reserves.

For an FX extension, suppose a buyer owes 30 EUR and a supplier receives SGD. A dealer quotes 1 EUR = 1.50 SGD, creating a contractual 45 SGD leg. The two payment legs must each be funded and settled in their respective systems; the FX rate is a given quote, not an endogenous prediction. If the SGD leg fails after EUR finality, principal exposure arises.

For an agentic access shock, remove the supplier from the agent consideration set. The authorized direct transaction quantity becomes zero even though X has the same deposit balance. Thus money, access, selection and settlement are independently necessary conditions in this particular modeled transaction.

31. Model limitations, falsification and institutional safeguards

The results are identities, existence constructions or conditional implications. They do not establish a calibrated general equilibrium, a universal definition of AI-native money, a measured effect of agentic trading on inflation, or an operational claim about HomeSelf deployment. In particular, nominal monetary aggregates are not intrinsically backed by a fixed physical commodity, and infrastructure service rights are not general monetary claims.

Testable questions include whether agent-mediated transactions exhibit greater peak-to-average settlement demand; whether exclusion from inferential consideration reduces direct demand conditional on prices and creditworthiness; whether collateral shocks amplify queueing in concentrated agent networks; and whether multi-domain interoperability reduces settlement delay without consolidating issuers.

Institutional safeguards require traceable issuers, disclosure of monetary claim characteristics, identity and authorization integrity, audit trails, privacy controls, independent risk management, legal settlement-finality analysis, consumer recourse and emergency controls. Different jurisdictions may impose distinct licensing and compliance obligations.

No future essay roadmap is included. The paper intentionally preserves unresolved equilibrium and empirical questions as limitations rather than announcing predetermined conclusions.

32. Consolidated constitutional conclusion

The economic role of agentic systems is to discover, evaluate and coordinate permitted transactions. Their technical ability to initiate instructions does not transfer to them monetary sovereignty, authority to issue regulated liabilities or the legal power to extinguish obligations outside the applicable settlement rules.

The axiomatic contribution is a disciplined separation of four layers: inferential access determines which opportunities can be considered; agentic allocation determines which feasible opportunities are selected; issuer-specific balance sheets determine the character and quantity of monetary claims; lawful settlement determines when obligations are discharged.

Human constitutional maxim: A command is not a payment. A ledger is not law. A claim is not its collateral. Efficiency is not justice. Agents may calculate and coordinate; institutions must remain accountable; humanity retains the authority to authorize, contest and correct.

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Source integrity. Institutional references establish external baseline concepts; they do not endorse ANOA. The ANOA/HomeSelf relationships are conceptual cross-references and not an independent verification of all source manuscripts.

Reference integrity: the institutional works provide external baseline concepts and do not endorse ANOA. The cross-paper associations are theoretical; full equivalence of source theorems has not been independently audited.

ANOA — ESSAY XV

Institutional integration: paradigm transitions, programmable money, CBDCs and stoic monetary constitutionalism

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Integration status. This scholarly supplement forms part of the consolidated Essay XV manuscript. It extends rather than replaces the balance-sheet and settlement constructions in Sections 1–32. All paradigm statements below are conditional, prospective, or comparative; they are not empirical claims that agentic monetary systems have already replaced existing institutions.

33. Research-corpus integration and epistemic boundaries

The ANOA and HomeSelf research programmes supply complementary layers: monetary accounting and settlement (this Essay), inferential consideration and allocation (Essay XIV and Computational Market Economics), macroeconomic coordination (Essay X), distributed production and distribution (Essay XII), architectural resilience (Essay XIII), and joint controllability (Essay IX). The cross-references below are conceptual; equivalence of proofs requires examination of the full underlying manuscripts.

Source	Transferable construct	Constraint on Essay XV
ANOA IX — 23971609	Cyber-physical stability; joint controllability; human custodianship	Model settlement infrastructures as coupled systems; require override, fail-safe and incident governance.
ANOA X — 23981930	Distributed macroeconomic equilibrium and institutional coordination	Do not infer allocative equilibrium from settlement balance or monetary aggregates.
ANOA XII — 24013915	Federated computational production, ownership and distribution	Keep monetary liquidity distinct from ownership, income and welfare.
ANOA XIII — 24016943	Architectural resilience and common-mode risk	Diversified financial claims may remain exposed to shared technological dependencies.
ANOA XIV — 24032436	Inferential access, agentic asset allocation, value preservation	Consideration, selection, authorization, settlement and service rights are separate states.
HomeSelf Computational Market Economics — 20692182; NDA — 20680894	Bounded consideration sets and network-dependent selection	Model access-driven demand attenuation separately from credit and liquidity constraints.
HomeSelf Computational Pricing Theory — 20781115	Representation friction; inferential cost; computational liquidity	Treat observed prices as potentially conditional on admissible alternatives.
HomeSelf Agent-Ready Market Infrastructure — 21241637	Operational readiness and transaction eligibility	Test technical service readiness without confusing it with monetary issuance.

Further HomeSelf work on the Computational Transmission Gap, Computational Intermediation, Inferential Monopoly and Computational Sovereignty offers candidate mechanisms and indicators, not established causal estimates. Its published research catalogue distinguishes theoretical papers from observed measurement programmes.

34. A taxonomy of monetary programmability

The term “programmability” is often used for fundamentally different institutional objects. This distinction is indispensable to a neutral comparison with CBDCs.

Dimension	Meaning	Constitutional / monetary implication
Programmable instructions	An agent or user automatically requests payment subject to mandate	The instruction is not money and not settlement.
Conditional payments	Execution depends on an agreed condition, e.g., delivery confirmation	Conditions govern payment execution, not necessarily the subsequent fungibility of received money.
Programmable money	Restrictions embedded in monetary units or enforceable claims concerning where, when or with whom they may be spent	Raises separate questions of fungibility, proportionality, equality, appeal and legal authority.
Programmable platforms	Rules-based coordination of claims, assets and settlement on common or linked infrastructure	Can use conventional ledgers, federated databases or DLT; finality remains legally specified.
Mandate-bound agentic spending	An agent has bounded permission to spend otherwise unrestricted money	Restrictions apply to agent authority, not necessarily to the money itself.
Prepaid service credits (HSC)	Contractual rights to specified HomeSelf services	Not general-purpose money, a CBDC, bank deposit or guaranteed store of monetary value.

Institutional clarification. The ECB states that the proposed digital euro would not be programmable money restricting spending by purpose, place, time or recipient, while conditional payments could be supported. The BIS discusses tokenised monetary arrangements and unified ledgers that may or may not employ DLT. Neither statement implies institutional endorsement of ANOA.

35. Paradigm-transition matrix: from conventional finance to agentic coordination

Axis	Conventional / digitised finance	AI-native federated hypothesis	New failure mode / safeguard
Discovery	Human search, brokers, interfaces	Agent-generated consideration sets	Silent exclusion; auditable admissibility and contestability
Allocation	Human or rule-based portfolio choice	Mandate-bound multi-agent optimization	Correlated models; diversification and independent checks
Transaction initiation	Human request or fixed recurring rule	Dynamic instructions within verifiable mandates	Runaway instructions; spending caps and kill switches

Axis	Conventional / digitised finance	AI-native federated hypothesis	New failure mode / safeguard
Money creation	Central-bank and regulated bank balance sheets	Issuer-specific creation unchanged unless legally reformed	Do not confuse API actions with issuance
Settlement	Banking rails and established payment systems	Coordinated multi-domain settlement	FX, liquidity and finality gaps; PvP/DvP and collateral
Governance	Issuer, operator, regulator	Separation of agent, operator, issuer and adjudicator	Clear accountability and judicial remedies
Market structure	Intermediaries and platforms	Federated inference and interoperable market access	Computational gatekeeping; portability and open standards
Value preservation	Real purchasing power subject to inflation and risk	Distinct service entitlements and monetary stores	No automatic HSC convertibility or capital protection

36. CBDCs, programmable money and AI-native money: comparative institutional matrix

Architecture	Issuer / claim	Agentic capability	Principal limitation
Commercial bank deposits	Commercial bank liability	API-based authorized payments; credit intermediation	Credit risk, bank access, settlement dependencies
Retail CBDC (proposed digital euro)	Central bank liability, subject to final design and legislation	Potential conditional payments and user-directed automation	Not intended as spending-restricted programmable money; implementation contingent
Wholesale central bank money	Central bank settlement liability	Institutional settlement of interbank obligations	Access and eligibility restricted to designated participants
Tokenised deposits	Bank liabilities represented on programmable rails	Potential atomicity and composability	Legal equivalence, interoperability, redemption and operational risks
Stablecoins	Private issuer claims, terms vary	Automated transfers on supported rails	Depegging, redemption, reserve and regulatory risk

Architecture	Issuer / claim	Agentic capability	Principal limitation
Restricted programmable vouchers	Purpose-limited claims or entitlements	Automated eligibility and spending restrictions	Not equivalent to fungible sovereign money; rights and exclusion concerns
Federated AI-native monetary circuit	No new issuer required; coordinates existing claims	Agent mandates, cross-domain routing, reconciliation and risk control	Interoperability, legal finality, governance and correlated agent shocks
HSC service rights	HomeSelf contractual prepaid service obligation	Access to infrastructure services supporting inferential allocation	Non-transferability, provider performance and service utility risk

37. Formal propositions and counterexamples

Proposition 19 — Mandate programmability does not imply monetary programmability

Let M be a fungible monetary claim and A an agent authorised to submit payment instructions only in mandate set K. Restricting instructions to K changes the agent's feasible action set but does not change the contractual redemption or acceptance properties of M. Proof. Choose two identical claims M held by principals with different agent mandates K1 and K2. The agents may submit different instructions, while the monetary claims remain identical. Hence mandate restrictions are not sufficient to establish monetary restrictions. QED.

Proposition 20 — Technical atomicity is insufficient for legal finality

Let T denote a technically atomic update and L the satisfaction of applicable finality rules. There exist systems where T=1 but L=0 (for example, a disputed or legally ineffective transfer). Therefore T does not imply L without an additional legal premise. This is a logical counterexample, not a claim that a specific settlement system lacks legal finality.

Proposition 21 — Increased agentic speed may increase peak liquidity demand

Consider n independent obligations of unit size settled sequentially using recycled liquidity: the minimum peak prefunding may be 1. If the same n obligations are required to settle simultaneously without netting or credit, gross peak prefunding may be n. Therefore faster synchronized instructions can increase peak liquidity needs under specified timing constraints, even if total nominal turnover is unchanged. This does not establish a universal effect on money velocity.

Proposition 22 — Access exclusion can attenuate direct monetary transmission

If an asset i is absent from every relevant agent's feasible consideration set, then direct purchases of i by those agents are zero, regardless of a positive increase in their purchasing budgets, holding consideration sets and mandates fixed. This is a conditional direct-channel result; indirect demand, human buyers, substitution and general equilibrium effects are not excluded.

Proposition 23 — Federation does not require blockchain

Construct two issuer-specific account ledgers connected by authenticated messages, compliance checks and a legally recognized settlement intermediary. Cross-domain transactions can be coordinated without replicated consensus over a shared blockchain. This existence construction proves non-necessity of blockchain, not equivalence of every federated architecture in resilience or performance.

38. Global macrofinancial implications and alternative scenarios

Scenario	Possible economic effect	Countervailing risk	Research / policy test
High-access agentic economy	Lower search friction and more responsive demand	Winner-take-most consideration sets	Compare access-adjusted price dispersion and exclusion
Concentrated agentic gatekeeper	Fast coordination and scale efficiencies	Systemic exclusion and correlated trading	Stress-test common models, gateways and service outages
Federated pluralist infrastructure	Reduced single-provider dependence	Complexity and cross-domain legal uncertainty	Measure recovery, interoperability and legal settlement
Restricted programmable money	Targeted spending controls in specific instruments	Reduced fungibility and autonomy where applied	Assess necessity, proportionality and appeal rights
CBDC with conditional payments	User-selected automation on public money	Privacy, design and governance trade-offs	Distinguish payment conditions from money-use restrictions
Agentic cross-border trade	More rapid FX routing and procurement	Liquidity hoarding, FX mismatches, compliance gaps	Simulate PvP, haircuts, prefunding and correlated shocks

39. Stoic constitutional synthesis: a global monetary compact

The following are proposed normative principles, not enacted constitutional law or theorems of economics. Stoic language supplies an ethical orientation toward reason, restraint, responsibility and the equal dignity of persons; it does not itself determine the legal design of a monetary instrument.

I. Human primacy. No autonomous system obtains sovereignty from computational capability alone.

II. Monetary neutrality of lawful persons. Money should not become an arbitrary instrument for discriminating among lawful persons or beliefs.

III. Separation of power. The power to allocate, issue monetary liabilities, operate infrastructure, settle obligations and adjudicate disputes must remain institutionally distinguishable.

IV. Contestability and due process. Material denial of access, payment or execution requires intelligible grounds and effective remedies, subject to law.

V. Proportionality. Restrictions on payments or asset access must have a lawful basis and be necessary, proportionate and reviewable.

VI. Pluralism and interoperability. Economic coordination need not compel a universal currency, universal ledger or compulsory platform.

VII. Resilience and stewardship. Operators must plan for common-mode failures, recovery, human intervention and continuity of essential services.

VIII. Truth in monetary claims. A token, credit, account balance or digital record must disclose its issuer, legal nature, redemption rights and risks.

IX. Privacy and accountability. Payment systems should reconcile privacy with proportionate, lawful oversight and independent accountability.

X. Human welfare. Efficiency gains from agentic systems must be assessed against freedom, distribution, safety and institutional legitimacy.

Constitutional maxim: A command is not a payment. A ledger is not law. Programmability is not legitimacy. Speed is not solvency. Access is not allocation. Intelligence is not sovereignty. Monetary architecture exists to serve persons, not to govern them without consent.

40. Integrated conclusions and scientific limits

The AI-native monetary paradigm is best formulated as a transformation of coordination, not an automatic replacement of sovereign money. Its distinctive mechanisms concern bounded inferential access, delegated agentic decisions, issuer-specific monetary claims, federated interoperability and settlement risk. CBDCs and programmable payment infrastructures can coexist with this architecture; programmable money with restrictions on use is a distinct institutional choice, not an intrinsic requirement of AI-native economics.

The manuscript offers accounting identities, existence constructions, comparative taxonomies and conditional propositions. It does not prove that any specific currency will dominate, that inflation will fall, that an HSC is a general store of value, or that blockchain is universally superior or inferior. Full stock-flow consistent multi-currency equilibrium and quantitative transmission effects remain open research questions. No future essay roadmap is proposed.

References and institutional evidence — supplement

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41. Constitutional protocol federalism: integration with ANOA Essay VI

Source: Patrone, M. (2026). *ANOA — Essay VI: The Axiomatic Theory of Global Protocol Federalism and Constitutional Order in AI-Native Societies.* Zenodo. DOI: 10.5281/zenodo.23861775.

Essay VI supplies a constitutional and institutional layer for Essay XV. Its published abstract distinguishes economic representation, computational inference, delegated authorization, distributed execution and monetary settlement; it proposes interoperable technical standards across autonomous federations without requiring territorial sovereignty or a single monetary infrastructure. It also distinguishes the legitimate economic role of a founding protocol architect from political sovereignty or unrestricted constitutional power.

Essay XV extends this separation to the monetary circuit. A common interoperability protocol can define message semantics, proofs of mandate, reconciliation and exception handling, while monetary liabilities remain obligations of their respective issuers and settlement finality remains governed by applicable law. Thus protocol commonality is compatible with monetary and jurisdictional plurality.

42. Separation of authority, liability and protocol control

Let domains d in D maintain issuer-specific monetary liabilities L(d,k,t), and let P be an interoperability protocol. A protocol-valid instruction v(P,m)=1 is a necessary technical condition for processing under that protocol, but it is not sufficient for a legally authorized transfer or discharge of obligations.

Conditional proposition 24 — Protocol validity is not settlement finality. There exists a message satisfying protocol validation for which final settlement has not occurred. **Proof:** Consider a correctly signed and schema-valid payment instruction that remains queued for insufficient liquidity or is rejected under mandatory legal controls. Protocol validity holds while final settlement does not. QED.

Conditional proposition 25 — Federated interoperability does not require a common issuer. Distinct monetary issuers may exchange interoperable instructions and proofs through a common protocol without merging their balance sheets. **Proof:** Define two independent issuers and a message protocol supporting authenticated instructions, confirmation and reconciliation; each issuer preserves its own ledger and liability. No common issuance is required by construction. QED.

These are existence and separation results, not proofs of universal interoperability or of a deployable cross-border settlement system.

43. Paradigm comparison: constitutional monetary architecture

Dimension	Centralized / restricted design	Federated AI-native design (candidate)
Authority	Operator policy may dominate interface	Mandates, legal jurisdiction and protocol governance remain distinct
Currency	One settlement asset may be preferred	Multiple sovereign and private liabilities can coexist
Programmability	Restrictions may attach to monetary instrument	Conditions can attach to authorized payment instructions
Protocol architect	Can be mistaken for monetary sovereign	Standards steward with bounded, reviewable authority

Dimension	Centralized / restricted design	Federated AI-native design (candidate)
Finality	Platform confirmation may be confused with settlement	Issuer and legal finality checked separately
Disputes	Single operator may control remedies	Federated recourse, auditability and appeal mechanisms
Systemic risk	Concentration in operator or ledger	Shared dependencies must still be stress-tested

44. Constitutional safeguards and the stoic boundary

The institutional consequence is not that a technical federation constitutes a new state, central bank or universal monetary authority. Rather, it can coordinate otherwise independent institutions under expressly limited and reviewable rules. The same separation applies to the founding architect: intellectual property, remuneration and stewardship do not confer sovereignty over participants or their money.

A constitutionally bounded monetary protocol should therefore provide for: explicit scope of delegated authority; auditability and revocation; issuer-specific liability; human recourse; proportional and non-discriminatory access criteria; independent review of protocol changes; privacy-preserving compliance; operational fallback; and legally effective settlement.

We govern only what we can justify, authorize and correct. A protocol may coordinate the world; it must never claim to own it.

45. Source integration and scientific limits

This integration is grounded in the public Zenodo record and abstract for Essay VI. Its full mathematical apparatus has not been independently reconciled with every proposition in Essay XV. The constitutional principles are normative proposals, not enacted law. No blockchain necessity, common currency, institutional adoption or legal recognition is inferred from this cross-paper relationship.

Reference: Patrone, M. (2026). *The Axiomatic Theory of Global Protocol Federalism and Constitutional Order in AI-Native Societies.* ANOA Essay VI, Zenodo. https://doi.org/10.5281/zenodo.23861775